IMPAIRED TRANSPORTATION VEHICLE OPERATOR SYSTEM

BACKGROUND OF THE INVENTION

The invention pertains to systems for detecting impairment of the operating ability of transportation vehicle operators, especially motor vehicle operators, and for altering the operator, and possibly also operators of nearby vehicles, when a state of operator impairment is detected.

It is well known that a great many serious injuries and fatalities are caused each year by motor vehicle accidents resulting from impairment of driving ability of the vehicle operator, which may arise from a number of different causes. Many such accidents are caused when operators have driven too long without sleep, and begin to fall asleep at the wheel, often without realizing their state of impairment. Even if the operator does not actually fall completely asleep, the operator in the sleepy state will have substantially impaired alertness and reflexes, and may be unable to respond in time to some hazard encountered in traffic.

Or an operator may have consumed alcoholic beverage, and may have reached a greater state of intoxication, than he or she realizes. Such partial intoxication, besides substantially dulling the reflexes, can also make the operator sleepy and generally less alert to the requirements of proper driving in traffic.

There are a variety of other physical conditions which may cause an operator to become too sleepy to safely operate the vehicle. Narcolepsy, for example may cause an operator to suddenly fall asleep, without warning. Sometimes an operator may suddenly become too sleepy, or insufficiently alert, as a result of the effects of aging.

In many instances an early sign of imminent serious operator impairment, is a change in inclination of the head, which will be different in nature from normal head inclinations that occur during driving. Fakhar et al, "Effect of Sound and Vibration on Vigilance", Laboratoire Energie Nuisances (LEN) (France), INRETS No. 153, 1992, at 90–92.

Research has confirmed this correlation between change in head inclination and reduced attentiveness. This is attributed to physiological changes in muscle tone, resulting in a progressive change in head and neck alignment, culminating in "nodding off". The time profile of this change in head inclination is different than normal head motion of an alert operator.

There is thus a need for a system which can reliably and automatically sense change in operator head position and motion over time, and can compare the time profile of the operator head motion with various profiles of normal and impaired operator head motion, and thus automatically detect a state of substantial operator impairment, and which can, upon detecting such an impaired operator state, activate one or more alarm devices, to alert the operator, and possibly also operators of nearby vehicles, to the fact that the operator is impaired. And there is a need for a system which can accomplish these objectives independently of variations in operator head positions resulting from variations in operator height.

The present invention accomplishes these objectives by the general approach of electronic detection and analysis of operator head motion, using an array of capacitive coupling sensors above the operator, and a microprocessor to analyze amplified signals from the sensors, to obtain a continuous record of operator head motion, for comparison with various profiles stored in the memory of the microprocessor; the microprocessor activates the warning device or devices when the impaired operator condition is detected.

SUMMARY OF THE INVENTION

The invention employs a capacitive coupling sensing system, having an array of at least three dual adjacent electrode capacitive coupling sensors, placed in the headliner above the operator's seat, with all sensors driven by a single oscillator, which sensors are used to sense operator head position and motion. The signal from each sensor is affected by presence and proximity of the operator's head which changes the capacitive coupling existing between the adjacent electrodes. Each sensor consists of a multilayer printed circuit board, or series of overlaid boards. The signals from the sensors are fed through an electronic signal processor containing a plurality of amplifiers of varying gain, to optimize sensitivity for each of at least two ranges of distance from the sensor array to the operator's head, a low gain amplifier being used for the near range, tall operator case, and a high gain amplifier being used for the far range, short operator case. Outputs from the sensors, after processing and amplification, are converted by an analog to digital converter ("ADC") and analyzed by a microprocessor to determine the operator's head position and motion, through triangulation analysis of distances from the operator's head to each sensor. The microprocessor records, tracks and compares the operator head motion data to stored profiles of normal head motion and impaired head motion, to detect any head motion indicative of operator impairment. When operator impairment is thus determined, the microprocessor activates any of a variety of warning devices, to warn and alert the operator and possibly also operators of other nearby vehicles, that there is a state of operator impairment, so as to hopefully wake up the operator, in cases of impairment by sleepiness.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is plan view of the array of three capacitive coupling proximity sensors.

FIG. **2** is a side elevational view of the configuration of the preferred embodiment, partially in section, in an automobile.

FIG. **3** is a schematic view of the signal processing circuitry, and the signal processing, analysis and alarm activation means circuitry, of the preferred embodiment.

FIG. **4** is a side elevational schematic illustration of the connection of the sensor array and the signal processing, analysis and alarm activation means circuitry, of the preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, in which like reference numbers denote like or corresponding elements, the principal components of the apparatus are an array of three capacitive coupling sensors **10**, each mounted on the top side of the headliner **12** which is secured beneath the vehicle roof **14** above the head **16** of operator **18**; signal processing circuitry **20** to filter the signals and extract changes in signal levels; a low gain amplifier **22** and a high gain amplifier **24**, which each receive and amplify output signals from signal processing circuitry **20**, conveyed to said amplifiers by wires **26** and **28**; an analog to digital converter (ADC) **30** which may be separate from or part of a microprocessor **32**; a